3.3.8 Weather - Winter Storms and Avalanche

3.3.8.1 Background

Winter storm hazards present one of the greatest threats to life of any hazard in Montana. Statistics on winter deaths are difficult to obtain, but nationwide there are on average 100 lives directly and indirectly lost to winter weather, more than lightning, hurricanes, or tornadoes. Winter storms are considered to be deceptive killers because most deaths are indirectly related to the storm. People die in traffic accidents on snow- or ice-covered roads, from hypothermia due to prolonged exposure to cold, and from heart attacks due to overexertion. About 70 percent of the winter storm-related deaths in the U.S. occur from people leaving motor vehicles and nearly 25 percent are from exposure to snow and cold during outdoor activities such as snow shoveling (NOAA, 2001).

Most Montana residents are readily prepared for snow storms each winter. Every community receives snow on an annual basis, so residents expect measurable snow several times each winter. Cold temperatures into the negative numbers are also common throughout the winter months. Major problems typically only occur during record snowfalls and extended periods of below zero temperatures. Rapid snowfall can overwhelm the plowing resources, making roadways impassable, and severely reduce visibility. Particularly heavy snows, early or late season snows, and ice events can damage infrastructure such as power lines, and block roads or damage structures with downed trees. Extended cold periods, especially when coupled with strong winds, can create dangerous situations for those outdoors or those without heat, such as in the case of a utility disruption.

Unlike tornadoes and severe thunderstorms, winter storms are generally slow in developing, often taking one to three days to mature. This does not in any way diminish their importance, nor their potential for causing loss of life and destruction. What it does mean is that the National Weather Service (NWS) is often able to provide advance notice of winter storms, in some cases, lead times of one to two days.

Photo 3.3.8-1
A deputy Sheriff Directs Traffic around a Crash in a Blizzard along U.S. Highway 2 near Columbia Falls on January 27, 2004. Heavy snow to the east near Essex triggered avalanches that knocked off cars on a freight train (Robin Loznak/The Daily Inter Lake – NWS, 2004).

A **blizzard** is a storm that has winds of at least 35 MPH with snow and blowing snow reducing visibility to near zero. Blizzards and other severe weather are common in Montana.

Some of the Montana winter weather statistics are listed below:

- The coldest time of the day in Montana usually occurs one hour after sunrise.
- Winter weather conditions can change very quickly in Montana. For example:
  - The greatest temperature change in 24 hours occurred in Loma on January 14-15, 1972. The temperature rose 103 degrees, from 54 degrees below zero to 49 degrees above zero. This is the world record for a 24-hour temperature change.
  - Great Falls went from -32°F to +15°F in 7 minutes, a national record.
- The coldest temperature ever recorded in Montana was -70°F at Rogers Pass north of Helena, on January 20, 1954. This is also a national record for the lower 48 states.
- Considering average daily low temperatures in January, the five coldest places (with weather recording stations) in Montana are:
  - Westby, Sheridan County, -5.8°F.
  - 10 miles north of Opheim, Valley County, -3.3°F.
  - 12 miles southeast of Opheim, Valley County, -2.9°F.
  - Redstone, Sheridan County, -2.7°F.
  - Culbertson, Roosevelt County, -2.0°F.
- The greatest recorded 24 hour snowfall of 48 inches occurred in May 1982, 7 miles south of Shonkin, Choteau County.
- During the winter of 1964-1965, Kings Hill totaled 426 inches of snow.

Source: NWS, 2004

Avalanche: A mass of loosened snow, ice, and/or earth suddenly and swiftly sliding down a mountain. In practice, assumed to be a snow avalanche unless another term such as ice, rock, mud, etc is used. Synonymous with "*snow slide*".

Avalanches occur throughout the mountains of Montana and, to a limited extent, elsewhere in the state. Avalanche hazards most-directly threaten winter recreationists, homes and businesses in mountainous regions, and communication and transportation networks. Two of Montana's ski areas, Bridger Bowl and Big Sky, are respectively the second and fourth most avalanche-prone ski resorts in the entire United States.

Of the major avalanche hazards, the interruption of communications lines probably occurs most frequently. Places of highest hazard include ski areas, mountain passes, and other areas where transmission lines cross avalanche paths. In regions where important highways or railroads cross areas subject to frequent snow slides, losses resulting from blocked roads, buried railroad tracks, and destroyed bridges can reach into the millions of dollars.

The complex interaction of weather and terrain factors contributes to the location, size, and timing of avalanches. In the absence of detailed scientific observation, any accumulation of snow on a slope steeper than 20 degrees should be considered a potential avalanche hazard.

The most certain sign of avalanche hazard is avalanche activity. Usually when one slope is hazardous, many of the nearby slopes are also hazardous. The historical record shows numerous cases where rescue parties searching for avalanche victims themselves become victims of the same avalanche cycle.

3.3.8.2 History of Winter Storms and Avalanches in Montana

Severe winter storms are one of Montana's greatest hazards. Winter storms may be categorized as ice storms, heavy snowfall, or blizzards. These storms vary in size and intensity and may affect a small part of the state or several states at once. Aside from the initial consequences, such as threats to vulnerable populations, freezing pipes, and snow removal costs, there are many residual effects, such as agricultural considerations and potential flooding concerns.

Photo 3.3.8-2
Highway 191 Near Malta, December 28, 2003. The highway was closed for several days following the record snowfalls in northeastern Montana. Many drivers were stranded during the storm that created this snow drift (NWS, 2004).

Winter storms impact the entire state annually. In February 1996, unusually cold temperatures covered most of the state, but communities in the northeast portion were exposed to life-threatening wind chills. The cold temperatures ruptured a natural gas line in Chouteau, compounding the life-threatening situation further. Later that year in November and December 1996, heavy snowfall and freezing rain caused power outages in western Montana and collapsed numerous buildings in the northwestern portion of the state.

Eastern Montana suffered an ice storm and blizzard in November 2000. The storm knocked out power to many homes and businesses from Plentywood to Ekalaka. Some locations did not have power restored for several weeks. Total estimated damages were $3 million. The storm was a federally declared disaster.

A major late season winter storm affected much of the Rocky Mountain Front in June 2002. Heavy snow fell for three days with snow accumulations ranging from 3 to 4 feet over the valleys, to 5 to 7 feet above 5,000 feet. This snow had a very high moisture content, which caused 301 power poles to break, 232 power pole cross arms to snap off, 521 splices, and over 30 miles of destroyed power lines. The power was out to over 2,500 customers, some for several days. Roads were closed over the entire Rocky Mountain Front region for 2 days. The deep snow cover resulted in the loss of over 3,200 livestock. Property damage was estimated at $3.2 million. The storm was a federally declared disaster for flooding (see *Section 3.3.3, Table 3.3.3-3*).

Since 1993, NOAA's National Climatic Data Center has recorded property damages or fatalities in Montana related to winter storms in every year except 1999 (NOAA-NCDC, 2007). During this time, 14 deaths and over $28 million in property damage has been documented (**Table 3.3.8-1**). On average, these storms cause approximately $2 million in property damages and 1 fatality each year (NOAA-NCDC, 2007). Because winter storms are

a frequent occurrence in Montana, much of the property damage and injuries/fatalities associated with winter weather may be under reported.

Table 3.3.8-1 Summary of Winter Storm Losses in Montana (1993-2006)

Type	Dates	Death	Injuries	Property Damage
Snow and Ice Events with Property Damage and/or Fatalities	1993-2006	14	23	$28,028,000

Source: NOAA-NCDC, 2007

Another cause of winter storm related fatalities are avalanches. From 1985 to 2003, there were 41 avalanche fatalities in Montana, representing more than 10 percent of the nationwide avalanche related deaths (**Figure 3.3.8-1**) (CAIC, 2007). Most of these fatalities were recreationists such as skiers, snowboarders, snowmobilers and climbers. In 2006 alone, Montana had 6 fatalities due to avalanches, representing 30 percent of the nationwide total for that year (CAIC, 2007). **Table 3.3.8-2** presents a summary of the recent avalanches.

Figure 3.3.8-1 U.S. Avalanche Fatalities by State
Source: CAIC, 2007

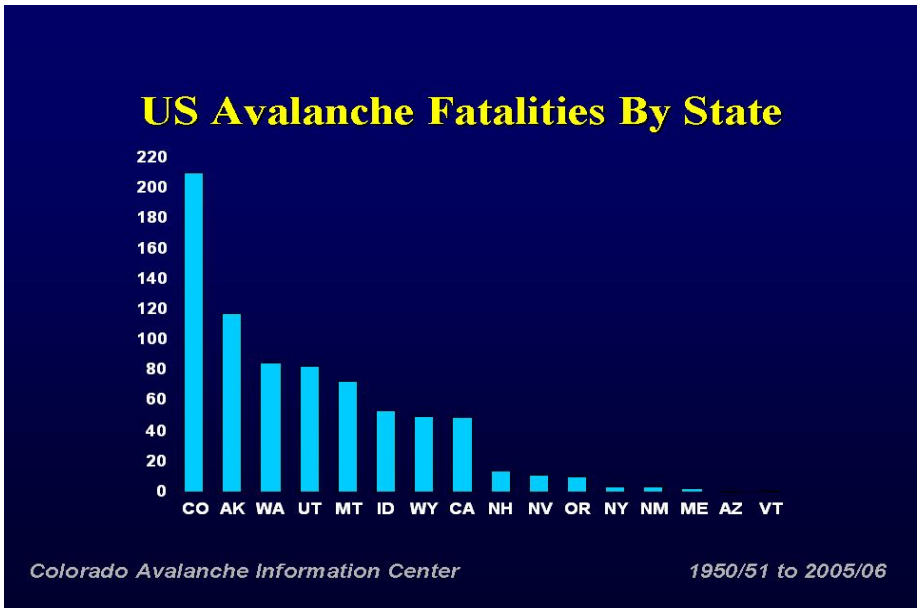

Table 3.3.8-2 Summary of Avalanches in Montana: 2006-2007

Date	Location	Activity	Fatalities	Injuries
12/16/2006	Scotch Bonnet Mountain near Cooke City	Snowmobiling	1	0
12/28/2006	Lionhead area near West Yellowstone	Snowmobiling	1	1
1/1/2007	Mt. Jefferson, Centennial Range	Snowmobiling	1	1
2/17/2007	Big Belt Mountains, northeast of Townsend	Snowmobiling	2	0
3/3/2007	Yellow Mountain near Big Sky	Skiing	1	0

Source: CAIC, 2007; GNFAC, 2007

3.3.8.3 Declared Disasters from Winter Storms and Avalanches

Numerous winter storm disasters have been declared in Montana. **Table 3.3.8-3** summarizes disaster declarations from 1974 to 2006 and **Table 3.3.8-4** presents the disaster assistance granted to individual jurisdictions.

Table 3.3.8-3 Federal Winter Storm Disaster Declarations in Montana (1974 to 2006)

Date	Disaster No.	Type of Event	Areas Declared	Public Assistance ($)		
			Counties and Reservations	Federal	State	Local
November 2000	FEMA-1350-DR-MT	Winter Storm	Carter, Daniels, Dawson, Fallon, Richland, Roosevelt Sheridan, Wibaux	$2,049,746	$2,229	$681,019
April 2001	FEMA-1377-DR-MT	Winter Storm	Big Horn, Flathead, Lake, Yellowstone & Crow Reservation	$705,644	$439	$234,776
June 2001	FEMA-1385-DR-MT	Winter Storm	Gallatin, Missoula & Powell	$922,154	$18,938	$288,447
June 2002	FEMA-1424-DR-MT	Winter Storm	Glacier, Toole, Liberty, Hill, Pondera & Blackfeet Reservation	$1,361,886	$23,885	$430,077
TOTALS				**$5,039,430**	**$45,491**	**$1,634,319**

Source: MDES, 2007

Table 3.3.8-4 State Declared Winter Storm Disasters and Assistance in Montana

Year	PA or EO No.	Applicant	State	Local
1978	ST-78-1	Blaine County	$117,620	$23,714
1978	ST-78-2	City of Havre	$19,495	$18,200
1978	ST-78-3	Phillips County	$121,075	$22,085
1978	ST-78-4	Carter County	$76,008	$14,135
1978	ST-78-5	Valley County	$22,349	$29,681
1978	ST-78-6	Dawson County	$31,524	$27,508
1978	ST-78-7	Garfield County	$114,937	$41,484
1978	ST-78-8	Wibaux County	$47,990	$18,728
1978	ST-78-9	McCone County	$14,944	$19,117
1978	ST-78-10	City of Wolf Point	$10,231	$5,040
1979	ST-79-1	Judith Basin County	$201,825	$17,320
1979	ST-79-2	Sweet Grass County	$34,145	$10,174
1979	ST-79-3	Teton County	$247,818	$24,210
1979	ST-79-4	Golden Valley County	$66,693	$7,746
1979	ST-79-5	Carter County	$95,672	$13,370
1979	ST-79-6	Garfield County	$88,387	$13,800
1979	ST-79-7	McCone County	$15,790	$21,680
1979	ST-79-8	Wibaux County	$39,559	$15,650
1979	ST-79-9	Dawson County	$75,947	$20,949
1985	MT-85-1	Town of Neihart	$12,542	$243
1990	MT-2-90	Town of Browning	$2,493	$806
1996	EO2-96	Teton County	$2,288	$0
1996	EO29-96	Glacier County, Town of Browning,	$35,521	$0

Table 3.3.8-4 State Declared Winter Storm Disasters and Assistance in Montana

Year	PA or EO No.	Applicant	State	Local
		Blackfeet Reservation		
1996	EO30-96	City of Libby	$74,645	$0
2004	EO 8-04	Petroleum County	$11,282	$2,936
2004	EO 8-04	Daniels County	$22,504	$9,373
2004	EO 8-04	Garfield County	$31,389	$0
2004	EO 8-04	Richland County	$45,162	$22,294
2004	EO 8-04	Roosevelt County	$46,392	$43,444
2004	EO 8-04	Sheridan County	$26,239	$12,575
2004	EO 8-04	12 Cities & Towns	$66,713	$19,619
2005	MT-06-05	City of Glendive	$26,242	$0
TOTALS			**$1,845,421**	**$475,881**

Source: MDES, 2007

3.3.8.4 Vulnerability to Winter Storms and Avalanches

3.3.8.4.1 Statewide Vulnerability to Winter Storms and Avalanches

The entire state is considered vulnerable to affects from heavy snowfall and subzero temperatures from winter storms. The winter weather patterns dictate exposure to the severest winter weather. Arctic cold fronts typically enter the state from the northeast and may cross the Continental Divide, affecting the western portion of the state. Arctic fronts meeting wet maritime fronts often combine to cause heavy snowfall, which can occur in all parts of the state. The lowest temperatures are typically experienced in the northeast, whereas the heaviest snowfall most often occurs in the mountain regions. Exposure does not equate to vulnerability, as preparedness and awareness in the most exposed portions of the state reduce vulnerability. For those reasons, the entire state is considered equally vulnerable to affects from winter storms.

The avalanche hazard is more localized in mountain regions. Avalanche-prone areas are well known; avalanche chutes identify where they will likely occur again. Where communities have built or developments have encroached into steep mountainous terrain, the vulnerability increases. Most of the exposure to the population is in winter recreation areas.

3.3.8.4.2 Review of Potential Losses in Local PDM Plans

Figure 3.3.8-2 presents the Winter Storm Hazard Risk Map. The colors represent a high-medium-low risk rating based on information in the Local PDM Plans. The gray color indicates this hazard was not assessed in the Local Plan. The hatch pattern indicates the Local Plans were not available for review. For electronic users of the State Plan, clicking on a county or tribal reservation will take you to the Local Plan where further information is available.

Figure 3.3.8-2 Hazard Risk Map: Winter Storm

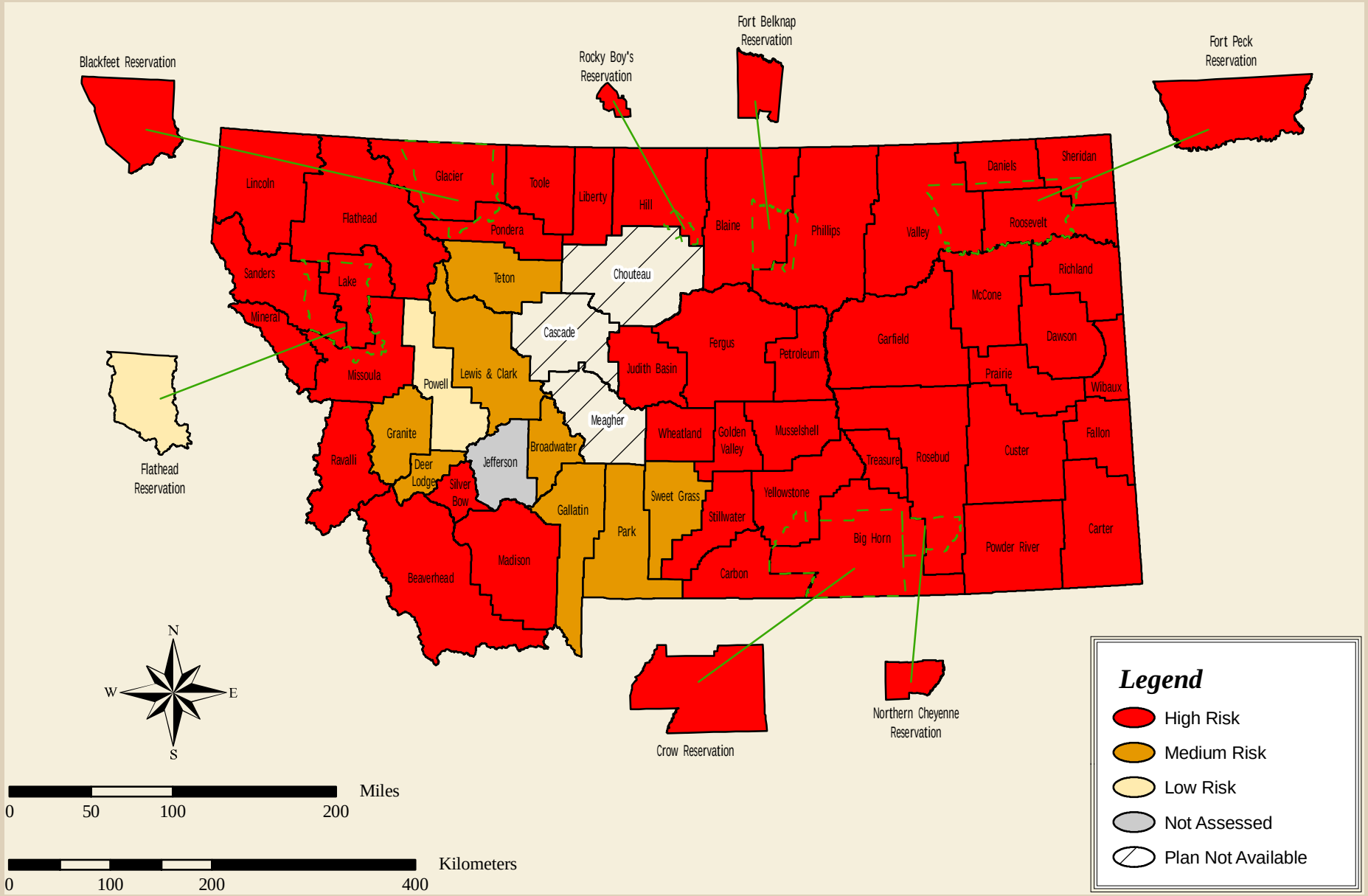

Table 3.3.8-5 presents a summary of potential loss estimates due to winter storms and/or avalanches as calculated in the Local PDM Plans. Winter storm/avalanche loss is described in terms of its effect on buildings, society and the economy, where generally:

- Building loss is presented either as a dollar value or a high-moderate-low rating and typically refers to the potential loss to critical facilities in the jurisdiction.
- Societal loss is presented either as the number of lives at risk or as a high-moderate-low rating representing the potential for loss of human life.
- Economic risk is presented as a dollar value or high-moderate-low rating referring to the potential impact to the economy of the local jurisdiction.

References cited in **Table 3.3.8-5** correspond to a description of the method used to calculate potential loss that can be found in *Section 7.14.*

Table 3.3.8-5 Potential Losses from Local Plans: Winter Storms

DES District	Jurisdiction	Building Loss	Societal Loss	Economic Loss	Reference
1	Deer Lodge County	Low	High	Moderate	1
1	Flathead County	Low	High	Moderate	8
1	Flathead Reservation	$41,591,600	1,343	NA	2
1	Granite County	Low	High	Moderate	1
1	Lake County	$41,591,600	1,343	NA	2
1	Lincoln County	1	1	NA	9
1	Mineral County	$500,000-$1 million	Moderate	NA	10
1	Missoula County	$500,000-$1 million	High	NA	10
1	Powell County	Low	Medium	NA	10
1	Ravalli County	$500,000-$1 million	Moderate	NA	10
1	Sanders County	$9,915,261	$280	NA	2
1	Silver Bow County	Low	High	Moderate	1
2	Blackfeet Reservation	$16,355,504	444.10	NA	2
2	Blaine County	$6,392,196	126.20	NA	2
2	Cascade County	U	U	U	
2	Chouteau County	U	U	U	
2	Fort Belknap Reservation	$2,168,150	48.70	NA	2
2	Glacier County	NA	NA	NA	
2	Hill County	$18,687,040	333.50	NA	2
2	Liberty County	Medium	High	NA	11
2	Pondera County	NA	NA	NA	
2	Rocky Boy's Reservation	$2,685,836	76.90	NA	2
2	Teton County	NA	NA	NA	
2	Toole County	Low-Medium	Low	NA	11
3	Beaverhead County	$18,500,000	477.60	NA	5
3	Broadwater County	Low	Moderate	Moderate	1
3	Gallatin County	Low	High	Moderate	12
3	Jefferson County	NA	NA	NA	
3	Lewis & Clark County	NA	NA	NA	
3	Madison County	NA	NA	NA	
3	Meagher County	U	U	U	
3	Park County	Low	High	Moderate	1

Table 3.3.8-5 Potential Losses from Local Plans: Winter Storms

DES District	Jurisdiction	Building Loss	Societal Loss	Economic Loss	Reference
3	Sweet Grass County	NA	NA	NA	
4	Carter County	High	High	High	12
4	Custer County	Moderate	Moderate	NA	13
4	Dawson County	$3,400,000	NA	High	8
4	Fallon County	NA	NA	$1 million	8
4	Garfield County	Moderate	High	Moderate	1
4	McCone County	$600,000	Moderate	$1,000,000	3
4	Powder River County	Moderate-High	High	Moderate	1
4	Prairie County	NA	NA	$1,000,000	3
4	Richland County	$600,000	Moderate	$238,095	3
4	Wibaux County	$3,300,000	Moderate	Thousands	3
5	Big Horn County	$800,000	Moderate-Severe	Moderate-Severe	3
5	Carbon County	$667,250	NA	$60,000	8
5	Crow Reservation	$800,000	Moderate-High	Moderate-High	3
5	Golden Valley County	$624,478	11.67	NA	2
5	Musselshell County	$8,185,501	146.60	NA	2
5	Northern Cheyenne Reservation	Millions	Moderate	Millions	3
5	Rosebud County	Moderate	High	Moderate	1
5	Stillwater County	$9,300,000	NA	NA	8
5	Treasure County	Moderate	High	High	1
5	Wheatland County	$4,934,643	67	NA	2
5	Yellowstone County	NA	NA	NA	
6	Daniels County	$5,353,554	77.50	NA	2
6	Fergus County	NA	7	5	4
6	Fort Peck Reservation	$19,090,684	478	NA	2
6	Judith Basin County	$3,348,000	52.40	NA	2
6	Petroleum County	NA	NA	NA	
6	Phillips County	$9,346,717	142.60	NA	2
6	Roosevelt County	$19,166,760	503.10	NA	2
6	Sheridan County	$10,880,198	160.30	NA	2
6	Valley County	$25,162,016	346.80	NA	2

Notes: U = Local PDM Plan not available for review; NA = not assessed in Local PDM Plan
Potential loss was computed was not computed in a uniform manner in Local PDM Plans. See number references in *Section 7.14* for a description of the methods used to calculate potential building, society and economic loss.

3.3.8.4.3 Vulnerability of State Property

State property that may be vulnerable to winter storms includes property which may be flooded by frozen water pipes, or collapsed due to heavy snow loads. Unprotected water lines or water lines above frost lines in the ground could expose buildings to potential flood damage. The same applies to building structures that may not be structurally sound to withstand high snow loads. Inventories of potentially-exposed buildings that may have unprotected water lines or insufficient structural integrity were not found.

Table 3.3.8-6 shows the claims for losses related to extreme winter weather. Many of these losses are related to flooding from frozen pipes. The claim record was only available beginning July 1, 1997.

Table 3.3.8-6 Loss Claims for State Facilities Caused by Extreme Winter Weather

Claim ID	Agency	Location	Cause of Loss	Date of Loss	Request	Indemnity
P98-025	University System	Missoula	Extreme Weather-Winter	1/11/1998	$3,000	$14,902
P98-031	Department Fish, Wildlife & Parks		Extreme Weather-Winter	1/28/1998		$3,468
P-5102	University System	Missoula	Extreme Weather-Winter	12/24/1998		$1,521
P-10685	Department of Transportation	Kalispell	Extreme Weather-Heavy Snow	1/24/2000		$4,500
P-12519	University System	Bozeman	Extreme Weather-Winter	12/10/2000	$3,000	
P-13159	University System	Billings	Extreme Weather-Winter	10/13/2001		$1,923
P-13921	University System	Billings	Extreme Weather-Winter	4/1/2002		$42,970
P-13949	University System	Bozeman	Extreme Weather-Winter	4/9/2002		$35,359
B-14896	University System	Bozeman	Extreme Weather-Winter	2/23/2003		$6,046
P-15720	University System	Bozeman	Extreme Weather-Winter	11/4/2003		$9,505
P-15880	University System	Bozeman	Extreme Weather-Winter	1/5/2004		$120,411
P-15886	Administration		Extreme Weather-Winter	1/6/2004		$1,761
P-16106	University System	Missoula	Extreme Weather-Winter	1/6/2004		$3,993
P-15889	University System	Butte	Extreme Weather-Winter	1/7/2004		$9,930
P-15901	University System	Havre	Extreme Weather-Winter	1/8/2004		$6,755
P-16215	University System	Missoula	Extreme Weather-Winter	1/9/2004		$3,455
P-15920	University System	Bozeman	Extreme Weather-Winter	1/13/2004		$12,688
P-15952	Health & Human Services		Extreme Weather-Winter	1/27/2004		
P-16106	University System	Missoula	Extreme Weather	12/8/2004		$3,933
P-17931	Department of Transportation	Lewistown	Extreme Weather-Heavy Snow	12/1/2005		$5,625
P-17640	University System	Bozeman	Extreme Weather-Winter	12/7/2005		$16,844
P-17656	University System	Missoula	Extreme Weather-Winter	12/10/2005		$8,170
P-17835	University System	Billings	Extreme Weather	11/26/2006		$9730
P-18539	Department of Justice, Law Academy		Extreme Weather–Winter	1/12/2007	$31,249	$47,945
P-18540	Department of Military Affairs		Extreme Weather-Winter	1/14/2007		$10,125.32
P-18555	University System	Bozeman	Extreme Weather – Extreme Cold	3/22/2007		$2,072
TOTAL					**$37,249**	**$383,631**

Source: DOA, Risk Management and Tort Defense Division, 2007

All parts of Montana are considered highly vulnerable to impacts from winter storms. All state-owned facilities will have equal exposure to winter storm hazards.

3.3.8.5 Impact of Future Development

Future development should have little to no impact from winter storms and extended cold weather. In the event of extreme conditions the most significant challenge may be to

provide access, sheltering or emergency services to residents who construct homes in remote areas (Gallatin County Hazard Mitigation Plan, 2006).

3.3.8.6 Winter Storms and Avalanche Data Limitations

Inventories of potentially-exposed buildings that may have unprotected water lines or insufficient structural integrity were not found. To evaluate State vulnerability, this type of evaluation would be needed, where buildings are geo-referenced and can be mapped digitally. To adequately evaluate avalanche hazards, the state buildings would need to be assessed with reference to slope and average annual snowfall. In addition, analysis of statewide avalanche hazard areas has not been conducted. Additional inventories of unprotected versus protected power lines were not available from the various providers.

3.3.8.7 Winter Storms and Avalanche References

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